Methodology for Reusing Human Resources Management Standards

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Abstract

Employment Services (ESs), Public ones (PESs) and Private ones (PrEAs), are becoming more and more important for Public Administrations where their social implications on sustainability, workforce mobility and equal opportunities play a fundamental strategic importance for any central or local Government. The EU SEEMP (Single European Employment Market-Place) project aims at improving facilitate workers mobility in Europe. Ontologies are used to model descriptions of job offers and curricula; and for facilitating the process of exchanging job offer data and CV data between ES. In this paper we present the methodological approach we followed for reusing existing human resources management standards like NACE, ISCO-88 (COM) and FOET, among others, in the SEEMP project, in order to build a common "language" called Reference Ontology.

Keywords

Human Resources Management Standard, Human Resources Ontologies.

1. INTRODUCTION

Nowadays there is an important amount of investment in human capital for economic development. Human resources management refers to the effective use of human resources in order to enhance organizational performance [1]. The human resources management function consists in tracking innumerable data points of each employee, from personal records (data, skills, capabilities) and experiences to payroll records [1]. Human resources management has discovered the Web as an effective communication channel. Although most businesses rely on recruiting channels such as newspaper advertisements, online job exchange services, trade fairs, co-worker recommendations and human resources advisors, online personnel marketing is increasingly used with cost cutting results and efficacy.

Employment Services are becoming more and more important for Public Administrations where their social implications on sustainability, workforce mobility and equal opportunities play a fundamental, strategic importance for any central or local Government. The goal of the SEEMP[1] (Single European Employment Market-Place) project is to design and implement an interoperability architecture for e-Employment services which encompasses cross-governmental business and decisional processes, interoperability and reconciliation of local professional profiles and taxonomies, semantically enabled web services for distributed knowledge access and sharing. For this purpose, the resultant architecture will consist of: a Reference Ontology, the core component of the system, that acts as a common "language" in the form of a set of controlled vocabularies to describe the details of a job posting or a CV (Curriculum Vitae); a set of local ontologies, so that each ES (E-Employment Services) uses its own local ontology, which describes the employment market in its own terms; a set of mappings between each local ontology and the Reference Ontology; and a set of mappings between the ES schema sources and the local ontologies [3].

Studer et al. [7] defines an ontology as follows: "An ontology is a formal, explicit specification of a shared conceptualization. Conceptualization refers to an abstract model of some phenomenon. Explicit means that the type of concepts used, and the constraints on their use are explicitly defined. Formal refers to the fact that the ontology should be machine-readable. Shared reflects the notion that an ontology captures consensual knowledge, that is, it is not private of some individual, but accepted by a group".

A major bottleneck towards e-Employment applications of Semantic Web technology and machine reasoning is the lack of industry-strength ontologies that go beyond academic prototypes. The design of such ontologies from scratch in a textbook-style ontology engineering process is in many cases unattractive for two reasons. First, it would require significant effort. Second, because the resulting ontologies could not build on top of existing community commitment. Since there are several human resources management standards, our goal is not to design human resources ontologies from scratch, but to reuse the most appropriate ones for e-Employment services developed on the framework of the SEEMP project. In this paper we present the methodological approach we followed for reusing exist-

[1] http://www.seemp.org/

ing human resources management standards like NACE[2], ISCO-88 (COM)[2] and FOET[2] , among others.

This paper is organized as follows: Section 2 depicts the adopted methodological approach to build the SEEMP Reference Ontology from standards and already existing ontologies. Section 3 describes the resultant SEEMP Reference Ontology. Then section 4 describes some considerations with respect to the building process of the local ontologies. Then section 5 depicts the related work. Finally, section 6 offers some final conclusions.

2. METHODOLOGY FOR REUSING HUMAN RESOURCES MANAGEMENT STANDARDS

In this section we describe the adopted approach to build the SEEMP Reference Ontology. This methodological approach follows and extends some of the identified tasks of the ontology development methodology METHONTOLOGY [4]. This methodological approach consists of:

- Specifying, using competency questions, the necessities that the ontology has to satisfy in the new application.
- Selecting the standards and existing ontologies that cover most of the identified necessities.
- Semantic enrichment of the chosen standard.
- Evaluating the Ontology content.
- Integrating the resultant ontology in the SEEMP platform.

2.1 Specifying, using competency questions, the necessities that the ontology has to satisfy in the new application.

This activity states why the ontology is being built, what its intended users are, and who the end-users are. For specifying the ontology requirements we used the competency questions techniques proposed in [5].

- Intended uses of the ontology. The purpose of building the Reference Ontology is to provide a consensual knowledge model of the employment domain that could be used by ESs, more specifically within the ICT (Information and Communication Technology) domain.
- Intended users of the ontology. We have identified the following intended users of the ontology: candidates, employers, public or private employment search service, national and local governments; and European commission and the governments of EU countries.
- Competency Questions. These questions and their answers are both used to extract the main concepts and their properties, relations and formal axioms of the ontology. We have identified sixty competency questions; they are described in detail in subsection 7.1.3 of the SEEMP deliverable D32 "Supporting the State of the Art". An example of the competency questions is: *Given the personal information (name, nationality, birth date, contact information) and the objectives (desired contract type, desired job, desired working conditions, desired salary) of the job seeker, what job offers are the most appropriate?*
- Terminology. From the competency questions, we extracted the terminology that will be formally represented in the ontology by means of concepts, attributes and relations. We have identified the terms (also known as predicates) and the objects in the universe of discourse (instances); they are described in detail in subsection 7.1.4 of the SEEMP deliverable D32 "Supporting the State of the Art".

2.2 Selecting the standards and existing ontologies that cover most of the identified necessities.

In order to choose the most suitable human resources management standards for modeling CVs and job offers, the following aspects have been considered: The degree of coverage of the objects identified in the previous task, this aspect has been evaluated taking into account the scope and size of the standard. However, a too wide coverage may move us further away the European reality, therefore we have tried to find a tradeoff between this aspect and the following one: the current european needs, it is important that standard focuses on the current European reality, because the user partners involved in SEEMP are European, and the outcoming prototype will be validated in European scenarios; and the user partners recommendations, in order to asses the quality of the standards, the opinion of the user partners is crucial since they have a deep knowledge of the employment market.

Besides, when choosing the standards, we also took into account that the user partners of SEEMP selected the ICT domain for the prototype to be developed in SEEMP. Hence, the chosen standards should cover the ICT domain with an acceptable degree. The standards that finally were chosen are outlined in section 3.1. In the case of the occupation taxonomy, as it will be shown, we have chosen one standard, but then we have taken some concepts coming from other classifications, in order to obtain a richer classification for the ICT domain.

When specifying job offers and CVs, it is also necessary to refer to general purpose international codes such as country codes, currency codes, etc. For this aim, the chosen codes have been the ISO codes, enriched in some cases with user partners classification.

Finally, the representation of job offers and CVs also require temporal concepts such as interval or instant. So, in

[2] Available through RAMON Eurostat's Classifications Server at http://ec.europa.eu/comm/eurostat/ramon/

order to represent these concepts in the final Reference Ontology, the DAML time ontology[3] was chosen.

2.3 Semantic enrichment of the chosen standard.

This activity states how we enrich the human resources management standards, the time ontology, the currency classification, the geographic location classification and language classification. We have followed the process of:

- verifying all concept taxonomies;
- establishing ad hoc relationships among concepts of different taxonomies;
- specifying concept attributes for describing concept features needed;
- defining formal axioms.

2.4 Evaluating the Ontology content.

The evaluation activity makes a technical judgment of the ontology, of its associated software environments, and of the documentation. We will evaluate the Reference Ontology using the competency questions identified in the first task.

2.5 Integrating the resultant ontology in the SEEMP platform

UPM[4] and LFUI[5] will work together in this task in order to integrate the resultant ontology into WSML language at design time, so that, the SEEMP Platform will be able to deal with this ontology at run time.

3. SEEMP REFERENCE ONTOLOGY

The Reference Ontology described in this section will act as a common "language" in the form of a set of controlled vocabularies to describe the details of a job posting and the CV of a job seeker. The Reference Ontology was developed following the process described in detail in section 2 and with the ontology engineering tool WebODE [4]. The Reference Ontology is composed of thirteen modular ontologies: *Competence*, *Compensation*, *Driving License*, *Economic Activity*, *Education*, *Geography*, *Job Offer*, *Job Seeker*, *Labour Regulatory*, *Language*, *Occupation*, *Skill and Time*. Figure 1 presents:

- These thirteen modular ontologies (each ontology is represented by a triangle). Ten of them were obtained after wrapping the original format of the standard/classification, using ad hoc translator or wrapper for each standard/classification.
- The connections between the ontologies by means of ad hoc relationships. Such relationships will be defined (identifying its domain and range) between specific concepts inside these ontologies later on.

3.1 Wrapping human resources management standards

As it was mentioned before, these ontologies have been developed following existing human resources management standards and systems classifications, and they are:

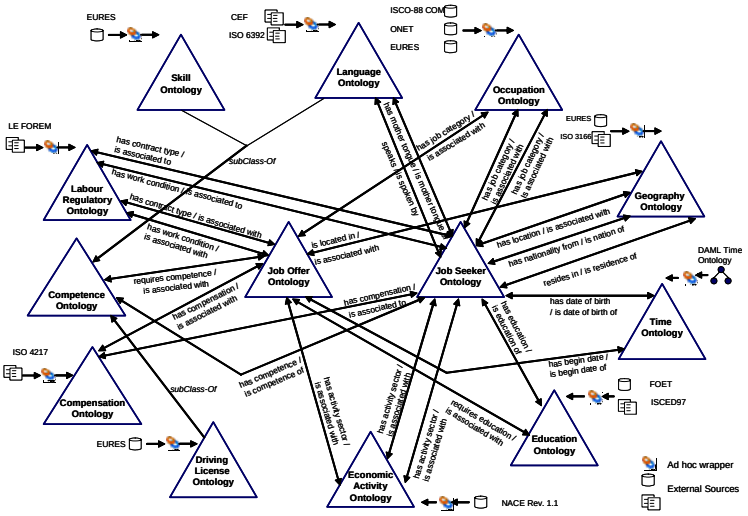

Figure 1. Main ad-hoc relationships between the modular ontologies

- *Compensation Ontology* which is based on the ISO 4217[6] . The ISO 4217 is expressed in HTML format. It is a list of 254 currency names and codes. The resultant Compensation Ontology has 2 concepts: `Currency` and `Salary`. For every currency element specified in the ISO 4217 a different instance of the `Currency` concept is defined. So, the `Currency` concept has 254 instances. An example of instance of the `Currency` concept is `UNITED STATES - US Dollar`.
- *Driving License Ontology* which is based on the levels recognized by the European Legislation[7]. This classification is expressed in HTML format and it is a list of 12 kinds of driving licenses. The resultant Driving License Ontology just has the `Driving License` concept; and for every kind of driving license specified in the European Legislation a different instance of the `Driving License` concept is defined. An example of instance of the `Driving License` concept is `A1 - Light weight motorcycle`.
- *Economic Activity Ontology* is based on the NACE Rev. 1.1[8]. This standard is expressed in MS Access da-

[3] http://cs.yale.edu/homes/dvm/daml/time-page.html

[4] Universidad Politécnica de Madrid is a technical partner of the SEEMP project, http://www.oeg-upm.net/

[5] Leopold-Franzens University Innsbruck is a technical partner of the SEEMP project, http://www.deri.at/

[6] http://www.iso.org/iso/en/prods-services/popstds/currencycodeslist.html

[7] http://ec.europa.eu/transport/home/drivinglicence/

[8] Available through RAMON Eurostat's Classifications Server at http://ec.europa.eu/comm/eurostat/ramon/

tabase format and it is a classification of 849 economic activities. The resultant Economic Activity Ontology has 849 concepts. In this case we have defined a concept for every element of the NACE taxonomy in order to preserve the hierarchy.

- *Occupation Ontology* is based on the ISCO-88 (COM)[9], ONET[10] and European Dynamics[11] classification of occupations. ISCO-88 (COM) and ONET are expressed in MS Access database format; European Dynamics classification of occupations is stored in an ORACLE database table. ISCO-88 (COM) is a classification of 520 occupations; ONET is a classification of 1167 occupations and the European Dynamics classification has 84 occupations. The resultant Occupation Ontology has 609 concepts. For this ontology we have extended manually the ISCO-88 (COM) classification with European Dynamics and ONET classifications for ICT occupations. In this case we have defined a concept for every element of the resulting extended taxonomy in order to preserve the hierarchy.
- *Education Ontology*, the education fields are based on the FOET[9] and the education levels are based on the ISCED97[9]; both of them are expressed in MS Access database format. FOET has 127 education fields and ISCED97 has 7 education levels. The resultant Education Ontology has 130 concepts. For the education levels we have defined the `Education Level` concept; and for every education level specified in ISCED97 a different instance of the `Education Level` concept is defined. For the education fields we have defined a concept for every element of the FOET taxonomy in order to preserve the hierarchy.
- *Geography Ontology* is based on the ISO 3166[12] country codes and the European Dynamics classifications: Continent and Region. The ISO 3166 is expressed in XML format; Continent and Region classifications are stored in ORACLE database tables. The ISO 3166 has 244 country codes and names; Region classification has 367 regions and Continent classification has 9 continents. The resultant Geography Ontology has four concepts, a `Location` as main concept, which is split into three subclasses: `Continent`, `Region` and `Country`. For every country element specified in the ISO 3166 a different instance of the `Country` concept is defined, so the `Country` concept has 244 instances. For every region element specified in the Region classification a different instance of the `Region` concept is defined, so the `Region` concept has 367 regions. Finally for every continent element specified in the Continent classification a different instance of the `Continent` concept is defined. An example of instance of the `Continent` concept is `EU – Europe`. An example of instance of the `Country` concept is `SPAIN – ES`. An example of instance of the `Region` concept is `Galicia`.
- *Labour Regulatory Ontology* is based on the LE FOREM[13] classifications ContracTypes and WorkRuleTypes, both of them expressed in XML format. ContractTypes classification has ten contract types and WorkRuleTypes has 9 work rule types. The resultant Labour Regulatory Ontology has 2 concepts. For every type of work condition or contract type considered by LE FOREM, a different instance of one of these two concepts (`Contract Type` or `Work Condition`) is included in the ontology. An example of instance of the `Contract Type` concept is `Autonomous`. An example of instance of the `Work Condition` concept is `Partial time`.
- *Language Ontology* is based on the ISO 6392[14] and the Common European Framework of Reference (CEF)[15]. The ISO 6392 is expressed in HTML format and CEF is a description in PDF format. The ISO 6392 has 490 language codes and CEF has 6 language levels. The resultant Language Ontology has 3 concepts: `Language`, `Language Level` and `Language Proficiency`. For every language element specified in the ISO 6392 a different instance of the `Language` concept is defined, so the `Language` concept has 490 instances. For every language level element specified in the CEF a different instance of the `Language Level` concept is defined, so the `Language Level` concept has 6 instances. An example of instance of the `Language` concept is `eng – English`. An example of instance of the `Language Level` concept is `A2 – Basic User`.
- *Skill Ontology* is based on European Dynamics Skill classification. This classification has 291 skills and it is stored in an ORACLE database table. The resultant Skill Ontology has 2 concepts: `Skill` concept with its subclass `ICT Skill`. For every skill element specified in the European Dynamic classification a different instance of the `ICT Skill` concept is defined. An example of instance of the `ICT Skill` concept is `Hardware programming`.
- *Competence Ontology* defines a concept called Competence as a superclass of the imported concepts

[9] Available through RAMON Eurostat's Classifications Server at http://ec.europa.eu/comm/eurostat/ramon/

[10] http://online.onetcenter.org/

[11] http://www.eurodyn.com/

[12] http://www.iso.org/iso/en/prods-services/iso3166ma/index.html

[13] LE FOREM is an user partner of the SEEMP project, http://www.leforem.be/

[14] http://www.iso.org/iso/en/prods-services/popstds/languagecodes.html

[15] http://www.cambridgeesol.org/exams/cef.htm

`Skill`, `Language Proficiency` and `Driving License`.

- *Time Ontology* is based on DAML ontology[16] and it is expressed in OWL format.

In order to make possible the enrichment of the standards, it was necessary to import them into the ontology engineering tool WebODE [4]. This process consisted of implementing the necessary conversions mechanisms for transforming the standards into WebODE's knowledge model. For this purpose we have developed for each standard/classification an ad hoc translator (wrapper) that transformed all the data stored in external resources into WebODE's knowledge model.

3.2 Enriching the ontologies

Once we transformed the standards into ontologies, the next step is to enrich them introducing concept attributes and ad hoc relationships between ontology concepts of the same or different taxonomies. We perform this task, doing the following.

- We created from scratch the Job Seeker Ontology, which models the job seeker and his/her CV information.
- We created from scratch the Job Offer Ontology, which models the job vacancy, job offer and employer information.
- We defined relationships between the concepts of the Job Seeker Ontology and the concepts defined on the standard (classification) based ontology.
- We defined relationships between the concepts of the Job Offer Ontology and the concepts defined on the standard (classification) based ontology.

Finally we present the Reference Ontology statistics. The Reference Ontology is composed of twelve modular ontologies. The Reference Ontology has 1609 concepts, 6727 class attributes, 60 instance attributes, 94 ad hoc relationships and 1674 instances.

4. LOCAL ONTOLOGIES BUILDING PROCESS

As it was mentioned before, the other components of the resultant SEEMP architecture will be: a set of local ontologies, so that each ES (E-Employment Services) uses its own local ontology, which describes the employment market in its own terms; a set of bidirectional mappings between each local ontology and the Reference Ontology; and a set of bidirectional mappings between the ES schema sources and the local ontologies.

In this section we provide some guidelines for the building process of the local ontologies. Based on the proposed SEEMP architecture, the possible options for building the local ontologies are:

- Option 1: Building local ontologies from the Reference Ontology.
- Option 2: Building local ontologies as a reverse engineering process from ES schema sources.

4.1 Building local ontologies from the Reference Ontology

In this case, we will probably need a specialization of the Reference Ontology and also an extension; by specialization we mean extending in depth the concepts we already have in the Reference Ontology; by extension we mean including application dependent concepts that appear in each ES schema source. Also mappings between local ontologies and Reference Ontology will not be complex. But on the other hand, mappings between local ontologies and ES schema sources will be complex. The building process is structured/guided by the architecture of the Reference Ontology and scoped with applications needs. The result should be a Reference Ontology friendly "local" ontology. If the customer needs data exchanges, he has to accept the exchange protocol with some readiness. This is an opportunity to impose an 'ontological order' on various users and systems. Regarding the evolution and change propagation dimension we have:

- Changes in the Reference Ontology imply a change in the mappings between local and global ontologies as well as probably changes in the mappings between the local ontologies and the ES schema sources.
- Changes in the Reference Ontology imply a change in the local ontology; in this case, the mappings Reference Ontology – local ontology would remain as they were. The mappings between the local ontologies and the ES schema sources should be updated.
- Changes in the ES schema sources imply changes in its local ontology (probably the part that is not a mirror of the Reference Ontology) and the mappings between local ontologies and ES schema sources, and probably minor changes in the mappings between local ontology and the Reference Ontology.

4.2 Building local ontologies as a reverse engineering process from ES schema sources

In this case, mappings between local ontologies and schema resources should not be complex. On the other hand, complex mappings will appear between the Local and Reference Ontology. The building process requires more sophistication of knowledge engineering and good acquaintance of all the data and their structures of the application: not easily found skill set in ES or any other operational/research organizations. Regarding the evolution and change propagation dimension we have:

- Changes in the ES schema sources imply a change in the local ontologies and, consequently, in mappings between sources and local ontologies as well as mappings between local and the Reference Ontology.

[16] http://cs.yale.edu/homes/dvm/daml/time-page.html

- Changes in the Reference Ontology imply changes in the mappings between local ontologies and the Reference Ontology, but it is not necessary to modify anything at the ES level.

4.3 Approach followed by SEEMP

In SEEMP project we follow a hybrid approach. On one hand, we select option 1 (building local ontologies from the Reference Ontology) for Job Seeker and Job Offer ontologies and other general purpose ontologies like, for example, the Time Ontology. On the other hand, we select option 2 (building local ontologies as a reverse engineering process from ES schema resources) for Occupation, Education, Economic Activity, Language, Compensation, Labour Regulatory, Skill and Driving License ontologies.

The reason of selecting option 1 for Job Seeker and Job Offer ontologies is because there are not significant differences between these ontologies and the way how each ES structures job seeker and job offer information. Consequently mappings between local ontologies and Reference Ontology will be simple, but mappings between local ontologies and ES schema sources will be complex. For the job seeker and job offer information local ontologies will share the same vocabulary (see [8]).

And the reason of selecting option 2 for the ontologies mentioned above is because each ES may have its own classification systems for the related information. It may happen that the local ontology shares some classification with the reference ontology (as there will happen in the European scope with the driving license classification). In that case, the reverse engineering process for that classification will be skipped, and that part of the reference ontology will be reused. By using option 2, mappings between local ontologies and Reference Ontology will be complex, but mappings between local ontologies and ES schema sources will be simple.

5. RELATED WORK

Currently the Human Resource Semantic Web applications are still in an experimental phase, but their potential impact over social, economical and political issues is extremely significant. [2] presents a scenario for supporting recruitment process with Semantic Web technologies but within German Government. In [6] we can find a brief overview of a Semantic Web application scenario in the HR sector by means of describing the process of ontology development, but its final goal is to merge ontologies.

6. CONCLUSIONS

In this paper we have presented the methodological approach we followed for reusing existing human resources management standards in the SEEMP Project. We also described the resultant Reference Ontology which acts as a common "language" in the form of a set of controlled vocabularies to describe the details of a job posting and the CV of a job seeker. The Reference Ontology was developed with the proposed methodology and with the ontology engineering tool WebODE. Finally, we have provided some guidelines for the building process of the local ontologies, and we conclude that the best option for building the local ontologies is building them following a hybrid approach.

An important conclusion of the work that we have carried out is that we can reuse human resource management standards in new applications following a systematic approach. Moreover, it is clear such a reuse can save time during the development of the whole system. However, it is not always possible to reuse a standard in a straightforward way, because sometimes the ideal standard does not exist for different reasons (different scope, outdated, etc.), and it is necessary to extend some "imperfect" standard with additional terminology coming from other standards or ad hoc classifications.

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REFERENCES

[1] Legge, K.: Human Resource Management: Rhetorics and Realities. Anniversary ed. Macmillan. (2005).

[2] Bizer C., Heese R., Mochol M., Oldakowski R., Tolksdorf R., Eckstein R.:"The Impact of Semantic Web Technologies on Job Recruitment Processes"; 7th Interna-tional Conference Wirtschaftsinformatik (2005)

[3] FOREM, UniMiB, Cefriel, ARL, SOC, MAR, PEP: User Requirement Definition D.1.SEEMP Deliverable (2006).

[4] Gómez-Pérez A., Fernández-López M, Corcho O.: Ontological Engineering. Springer Verlag. (2003)

[5] Grüninger M, and Fox MS.: Methodology for the design and evaluation of ontologies In Skuce D (ed) IJCAI95 Workshop on Basic Ontological Issues in Knowledge Sharing, (1995) pp 6.1–6.10

[6] Mochol M., Paslaru Bontas E.: Simperl: "Practical Guidelines for Building Semantic eRecruitment Applications", International Conference on Knowledge Management (iKnow'06), Special Track: Advanced Semantic Technologies (2006)

[7] Studer, R., Benjamins, V.R., Fensel, D.: Knowledge Engineering: Principles and Methods. Data and Knowledge Engineering. 25: (1998) 161-197.

[8] Swartout, W.R., Patil, R., Knight, K., and Russ, T.: Towards Distributed Use of Large-Scale Ontologies, AAAI-97 Spring Symposium on Ontological Engineering, Stanford University, May, (1997)